Health Maintenance System: An Application of Recovery Oriented Computing for HPEC Systems

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Until recently, the primary, single aspect of HPEC systems that has been most critical has been "performance", in terms of processor speeds and I/O throughput. As processor speeds and I/O throughput has continued to increase, and as the capability to build larger and larger systems has improved, the need for raw performance is becoming less critical. Now, it is the ability to achieve a high level of application availability that is becoming as critical as performance.

In this paper, we will present a CORBA based framework upon which highly available applications can be constructed. This framework, known as the Health Maintenance System, provides the application, system managers, and management tools with the ability to "manage" all resources within a system such that the "health" of the system can be maintained. The management of these resources involves the ability to "sense" the state of the resource, to control the resource, and to run tests on the resource in order to pro-actively detect any latent problems.

The primary facet of the framework is the "resource manager". The resource managers provide local management support for all system resources. In addition, the resource managers provide management access to clients, e.g., the application. This access is provided via a set of "client interface" modules that provide a wide variety of interfaces, e.g., APIs, agents, etc. It is this combination of resource managers and client interface modules that allow the framework to be easily configured for a specific HPEC system.

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Health Management System: An Application of Recovery Oriented Computing (ROC) Targeted at HPEC Systems

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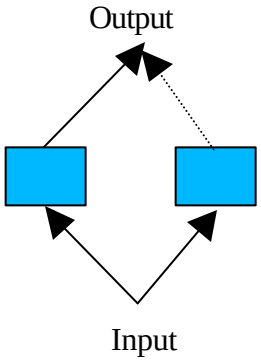
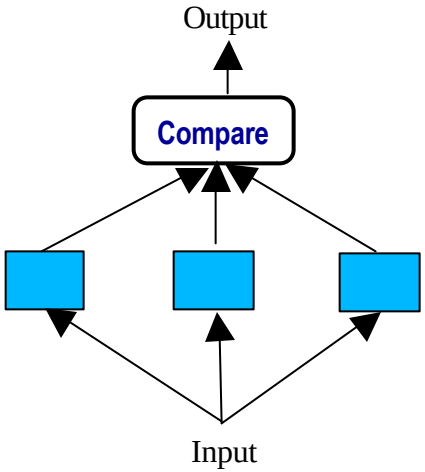
HA Approach: Redundancy

- Goal: Increase Mean Time To Failure
- Classes
  - Dual Redundancy (Hot Fail Over)
  - Triple Redundancy (Result Comparison)
- Redundancy at System/Component Level
- Drawbacks:
  - High Costs
  - Low Density
  - Additional Complexity





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SKY's HAA Approach: Recovery Oriented Computing

Two Basic Tenets:

- Failure Rates of Both Software and Hardware are Non-Negligible and Increasing
- Systems Cannot be Completely Modeled for Reliability Analysis (thus their failure modes cannot be predicted in advance)

Goal:

- Decrease Mean Time to Repair

ROC Mechanisms:

- Detection (Sensing and Diagnotics)
- Isolation
- Use of Excess Capacity (if available)
- Repair/Recovery

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Applying ROC to HPEC

Hardware:

- Quality Components
- Builtin Sensing of all Major Components
- Control of all Major Components (reset, etc.)
- Excess Capacity (where possible)

OS Middleware:

- Quality Components
- Builtin Sensing of all Major Components
- Control of all Major Components

Application:

- Quality Components
- Builtin Sensing of all Major Components
- Control of all Major Components
- Overall System Management (Sensing and Control)

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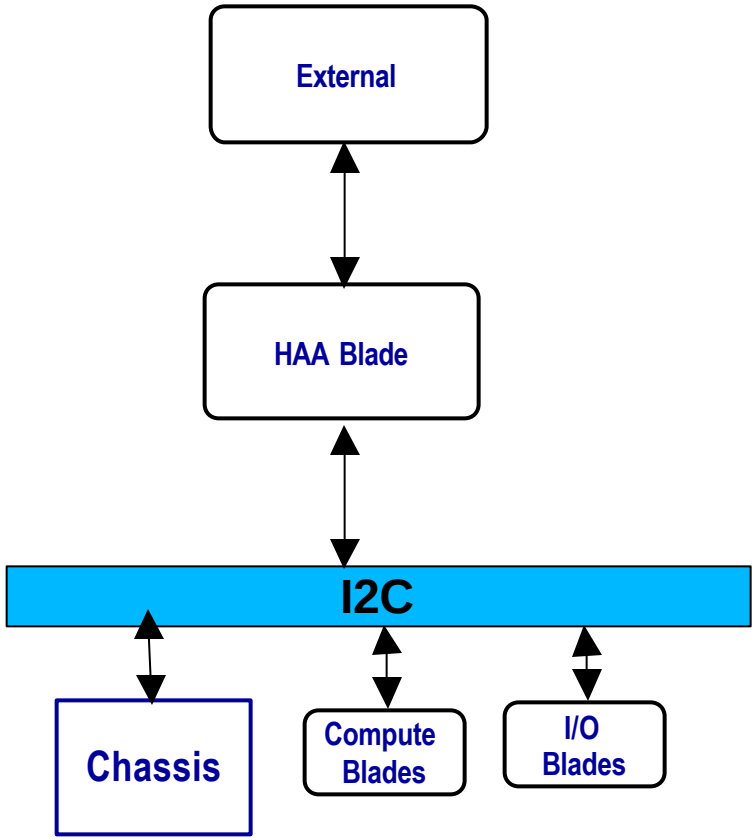
Hardware Support

- **HAA Support Blade**
  - Tini Management Processor (Java Processor)
  - I2C Integration
  - TCP/IP External Access
- **Compute/IO Blades**
  - Out-of-band Management Controller
  - Temperature Monitoring
  - Voltage Monitoring
  - Heart Beat Monitor
  - Power Control/Reset
  - I2C Integration
- **Chassis**
  - Fan Monitoring
  - Voltage Monitoring
  - Power Control/Reset



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Health Management System (HMS)

GOALS:

- Provide Capability to Instrument OS, Middleware, and Application (analogous to hardware instrumentation)
- Provide Uniform View of Entire System (hardware, OS, middleware, and application)
- Provide Integrated Diagnotics
- Provide Access Using Standard Interfaces
- Minimal Performance Impact
- Easily Extensible and Configurable (in order to meet individual application requirements)

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Health Management System (HMS)

- Server Objects: Sensors, Controllers, and Timers
  - Embedded within the hardware, OS, middleware, and application
  - Combined into a Resource Object
- Clients: Application, Management Tools, and Users
- Communication: Event Driven, Request Driven, and Timer Driven Messaging
- Lookup Services
- Extensible
  - Can support an arbitrary number of servers and clients
  - Application developers can add application specific servers
- Configurable
  - Which servers and clients are to run
  - When and where they are to run

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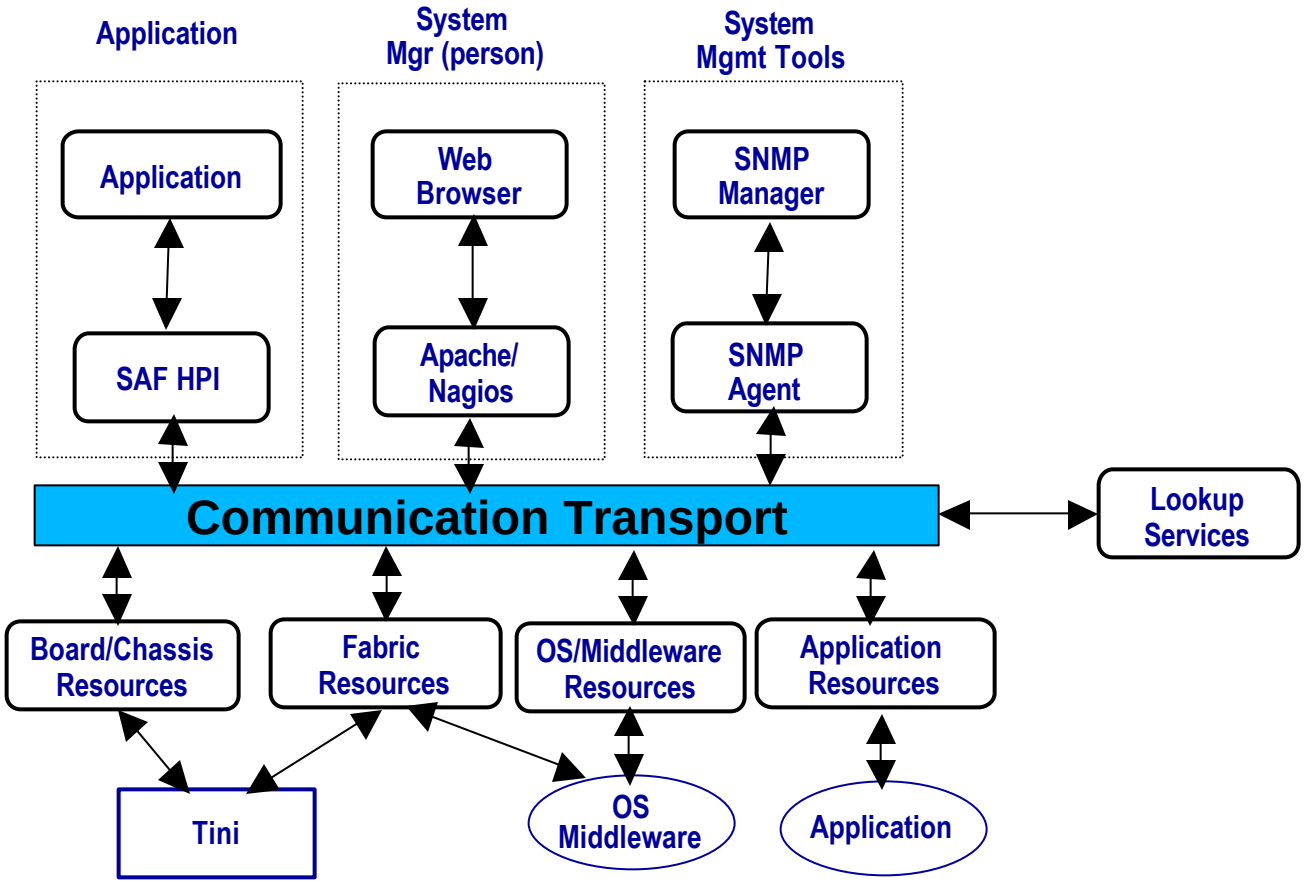
Example HMS Based System



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Health Management System

- Used to Monitor Resource Usage (Development and Runtime)
  - Hardware (temperature, voltage, etc)
  - OS/Middleware (processor load, data throughput, etc)
  - Application (queue lengths, wait times, etc)
- Used to Manage These Resources
- Used to Detect and Isolate Faults
- Used to Predict Possible Future Faults
- Used to Gather Statistics on Resource Usage and Performance
- Used to Determine the Health of Resources (Diagnotics)

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Future Directions

- Tight Integration with SKY Analysis Tools
- Tight Integration with SKY Development Tools
- Pattern-based Application Recovery Libraries
- Dynamic Insertion of Sensors/Controllers (Dynamic Probes)
- Support for Other Hardware Environments (Hot-Swap)